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Structural Analysis of Components of the Students for the Exploration and Development of Space Satellite (SEDSAT) for the Small Expendable Deployer System (SEDS) Project Office (5-34412)

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PREFACE

This technical report was prepared by the staff of the Research Institute, The University of Alabama in Huntsville. The purpose of this report is to provide documentation of the work performed and results obtained under Delivery Order 164 of NASA Contract No. NAS8-38609. Mr. William Gnacek was the principal investigator. Mr. Todd Matthews and Mr. Patrick Newton provided technical support.

The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official NASA position, policy, or decision unless so designated by other official documentation.

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Prepared for: Marshall Space Flight Center
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I have reviewed this report, dated 30 MAR 98 and the report contains no classified information.

Gary A Maddux
Principal Investigator

Approval:

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1.0 Objective

The goal of this project was to perform a stress analysis on the University of Alabama in Huntsville's SEDSAT1 satellite. The stress analysis was performed to ensure the satellite would operate safely under the given loads and constraints. Since the satellite was intended to be placed in orbit by the space shuttle, Marshall Space Flight Center (MSFC) was responsible for approving the transport of the satellite.

Because of the limited time, it was not possible to construct a finite element model analysis. Therefore, all of the calculations were hand calculations developed in Excel spreadsheets.

2.0 Statement of Work

The statement of work, as outlined in delivery order 164, was as follows:

UAH shall perform the following specific activities:

Perform structural analysis of the SEDSAT structure, structural interface, and attached mechanical elements.

These analysis shall include, but not be limited to, those required to demonstrate that the SEDSAT structure does meet the requirements of HHG-730-1503-07.

Provide technical documents and briefings that summarize all efforts performed. These documents and briefings shall include, but not be limited to: technical analysis; graphical representations; selected components, subsystems and systems specifications/ functional requirements; issues and recommendations.

3.0 Analysis

The satellite is designed as a cube that roughly measures one foot on each side. The six sides are made out of 6061-T6 aluminum plates, which are 1.0 inch thick. Each side panel is fastened to the adjacent side with ten #4-40 steel screws. The bottom plate is milled with an additional two-inch marmen clamp that is designed to mount to the Hitchhiker (HH) carrier system inside the cargo bay of the space shuttle.

Within the marmen clamp are three separation switches that are used to deploy the satellite. A tether line is connected to a spool in the cargo bay and to a tether arm on the satellite. At the time of deployment, the separation switches would disconnect the satellite from the cargo bay while the tether line held the satellite in place. The tether would then be cut once the satellite is at the correct orbit level.

The main equipment located within the satellite consists of two cameras, three antennas, several circuit boards, and two batteries. One camera is designed to take pictures of the earth while the other camera is pointed out into space. This information would then be relayed back to the space shuttle through the antennas. Two magnetorquers are used to control the movement of the satellite once it is in orbit. Each component is held in place with screws and/or bolts.

For the stress analysis, three main areas were looked at. First, the fasteners that held the six sides together were analyzed to determine if the satellite would hold together. This analyses was performed by MSFC personnel. Secondly, a side impact analysis was performed to determine if a loose component could penetrate the side of the satellite. And lastly, an analysis of all the fasteners that held down the individual components of the satellite was performed.

For each analysis, the ultimate loading placed on the satellite was determined from the Customer Accommodations and Requirements Specifications (CARS). This document details the design limits and requirements for payloads that are transported using the Hitchhiker carrier system. The maximum loads placed on the satellite occur at liftoff and at a possible return landing.

4.0 Conclusion and Recommendations

During the time frame allocated by the delivery order, members of the UAH Applied Research Program, with the cooperation of representatives from NASA investigated and conducted stress analysis of the SEDSAT1 satellite.

The main area of concern was with the design of the deployable 10m antennas. The placement of the holes for the antenna door hinge pin was too close to the edge of the antenna canister. Because of the load placed on the hinge pin, the stress analysis of this area suggested that more space would be needed between the holes and the edge of the material.

Due to other conflicts, SEDSAT1 was removed from flying on the space shuttle and moved to the Delta Launch Vehicle. This changed many of the design requirements for the mounting and deployment of the satellite that forced a new design for the satellite. Once this happened, the stress analysis became obsolete, and the task was concluded.